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(71) Applicant: 000228073  
Nippon Ester Co., Ltd.  
4-1 Hinakita-machi, Okazaki-shi, Aichi Prefecture

(72) Inventor: Takayuki IMAMURA  
1 Kamikawagoe, Hegoshi-cho, Okazaki-shi, Aichi Prefecture

(72) Inventor: Takeshi SATO  
4-1 Hinakita-machi, Okazaki-shi, Aichi Prefecture

(72) Inventor: Tetsuo MATSUMOTO  
49-6 Kutsushijo, Daiwa-cho, Okazaki-shi, Aichi Prefecture

**(54) Title of the Invention: VERY FINE POLYESTER YARN**

**(57) Summary**

**Object:** To provide a very fine polyester yarn that can be easily produced, has a good color tone, and imparts an outstandingly soft touch to knitted and woven goods.

**Constitution:** A very fine polyester yarn having a monofilament size of from 0.1 to 1 denier that has been obtained by a direct yarmaking process and is composed of polypropylene terephthalate or a polyester composed primarily thereof, which very fine polyester yarn has an intrinsic viscosity of at least 0.8, a b value of no more than 9, and a boiling water shrinkage factor of from 3 to 15%.

## SPECIFICATION

Claim

- (1) A very fine polyester yarn having a monofilament size of from 0.1 to 1 denier that has been obtained by a direct yarnmaking process, and is composed of polypropylene terephthalate or a polyester composed primarily thereof, which very fine polyester yarn has an intrinsic viscosity of at least 0.8, a b value of no more than 9, and a boiling water shrinkage factor of from 3 to 15%.

Detailed Description of the Invention

[0001]

(Field of Industrial Use)

This invention relates to a very fine polyester yarn that has an excellent hand and is especially ideal for [obtaining] woven and knit goods having an outstandingly soft touch.

[0002]

(Description of the Prior Art)

Very fine polyester yarn having a monofilament size of from 0.1 to 1 denier that is made of polyethylene terephthalate is used in all areas of garment-related applications, and particularly in dresses and jackets for ladies, as furry knit and woven goods having a good softness to the touch and drape. However, although very fine yarn made of polyethylene terephthalate such as this is able to impart some softness to the touch to woven and knit goods, because of the high Young's modulus of the polymer itself, [very fine yarn of this type] has not been able to confer an adequately soft touch.

[0003]

For this reason, a method has been proposed whereby, in order to obtain very fine yarn having an even smaller monofilament denier, polymer which is soluble in an aqueous solution of alkali and polymer which is only sparingly soluble therein are bicomponent spun and rendered into a woven or knit good, following which this is treated with an aqueous solution of alkali and the soluble polymer is eluted out and removed. However, in addition to being economically undesirable, another problem with this method is the large expenses entailed by wastewater treatment.

[0004]

Polypropylene terephthalate (PPT) has long been known as a polyester having a low Young's modulus, and its use in the form of fibers in carpets and the like has been proposed (Japanese Examined Patent Publication [Kokoku] No. 49-21,256 (1974), and U.S. Patent Nos. 3,584,103 and 3,681,188). However, because PPT has a poor heat stability, it readily discolors, and so has not been used as a garment fiber.

**[0005]****(Problems the Invention Sets Out to Resolve)**

The present invention sets out to provide a very fine yarn which is made of PPT or a polyester composed thereof, and which can easily be produced, has a good color tone, and is able to impart an outstandingly soft touch to woven and knit goods.

**[0006]****(Means for Resolving the Problems)**

The present invention resolves the above problems. The gist of the invention is a very fine polyester yarn having a monofilament size of from 0.1 to 1 denier that has been obtained by a direct yarnmaking process, and is composed of PPT or a polyester consisting primarily thereof, which very fine polyester yarn has an intrinsic viscosity of at least 0.8, a b value of no more than 9, and a boiling water shrinkage factor of from 3 to 15%.

**[0007]**

The present invention is described in detail below.

**[0008]**

The polyester in the present invention is PPT or a polyester consisting primarily thereof. Copolymerization ingredients such as isophthalic acid, phthalic anhydride, dodecanedicarboxylic acid, azelaic acid, sebacic acid, 1,4-naphthalenedicarboxylic acid, 2,4-naphthalenedicarboxylic acid, 4,4'-diphenyldicarboxylic acid, diphenoxyethanedicarboxylic acid, bisphenol A and p,p'-biphenol, as well as additives such as stabilizers, fluorescent agents and pigments may also be included within a range that does not compromise the properties of the PPT.

**[0009]**

The very fine polyester yarn must have an intrinsic viscosity of at least 0.8. When the intrinsic viscosity is less than 0.8, uneven fineness and yarn breakage frequently arise during spinning, making it impossible to stably obtain very fine yarn that is uniform.

**[0010]**

Moreover, the very fine polyester yarn must have a b value of no more than 9. If the b value becomes larger than 9, when the yarn is rendered into woven or knit goods, the yellowness becomes stronger, compromising the quality, which is undesirable.

**[0011]**

The polyester furnished for production of the very fine polyester yarn of the present invention can be produced by polycondensing the esterification product of terephthalic acid (TPA) with 1,3-propanediol (PD) using a suitable polycondensation catalyst and at a relatively low temperature.

**[0012]**

For example, this can be obtained by carrying out an esterification reaction on TPA and PD by a conventional technique so as to give an esterification product having an esterification conversion of from 92 to 98%, then adding to this product a polycondensation catalyst such as tetrabutyl titanate or sulfosalicylic acid, and carrying out a polycondensation reaction for 3 to 5 hours in vacuo and at a temperature of at least 240°C, but not more than 250°C. Given the same polycondensation catalyst, polycondensation reaction temperature and the like, the polyester b value becomes higher at longer polycondensation reactions and higher intrinsic viscosities.

[0013]

The very fine yarn of the present invention is produced by carrying out a direct yarnmaking method on the above polyester. This is a multifilament yarn having a monofilament size of from 0.1 to 1 denier, and a boiling water shrinkage factor of from 3 to 15%.

[0014]

When the monofilament size exceeds 1 denier, woven and knit goods having an outstandingly soft touch cannot be obtained. On the other hand, when the monofilament size is less than 0.1 denier, production by a direct yarnmaking process is difficult.

[0015]

When the boiling water shrinkage factor exceeds 15%, the hand when this has been rendered into woven or knit goods becomes hard, which is undesirable. When the boiling water shrinkage factor is less than 3%, the temperature of orientation and heat treatment during yarnmaking must be set high, as a result of which smoking of the lubricant and the like arise. This is undesirable because, in addition to production becoming difficult, the dyeability decreases.

[0016]

The denier of the very fine yarn may be selected as desired, within [the range afforded by] the combination of the required hand and the monofilament size.

[0017]

The very fine yarn of the present invention can be produced by melt-spinning, orienting, and heat-treating the above-described polyester at a high speed. For example, undrawn yarn obtained by melt spinning at a high spinning speed of about 2500 to 4500 m/min can be oriented at a draw ratio corresponding to about 20 to 40% of the required elongation as garment fibers, and heat-treated at a temperature of from 120 to 180°C so as to give the inventive very fine yarn. The fibers may have a circular cross-section, or may have a triangular or other modified cross-section.

[0018]

(Operation of the Invention)

Because the very fine polyester yarn of the present invention is composed of PPT, or a polyester composed primarily thereof, which has a low Young's modulus, even

though the monofilament size is from 0.1 to 1 denier, which is relatively large, when rendered into woven or knit goods, this becomes a product having a softness to the touch comparable to that of ultrafine polyethylene terephthalate yarn.

[0019]

(Examples)

The present invention is illustrated more concretely below by means of examples. The methods of measuring the properties are as follows.

(a) Intrinsic Viscosity  $[\eta]$ :

This was determined from the value measured using an equal-weight liquid mixture of phenol and tetrachloroethane as the medium, and at a temperature of 20°C.

(b) Boiling Water Shrinkage Factor (100W):

A load of 100 mg/d was applied to a combined filament yarn and a sample length  $L_0$  was measured, after which the sample was boiling water-treated for 30 minutes in a no-load state, then a load of 100 mg/d was once again applied and the sample length  $L_1$  was measured. The boiling water shrinkage factor was computed from the following formula.

$$100W (\%) = [(L_0 - L_1)/L_0] \times 100$$

(c) Hand:

The softness to the touch, sense of slickness and drape were evaluated on an 8-point scale by means of sensory testing. When these properties were at their best, a score of 8 was assigned, and a score of 1 was assigned when they were at their worst. (8 was the highest score, 1 was the lowest, and cases where all the properties were 5 or higher were regarded as "passing")

(d) b Value (Color Tone):

This was measured using a 280 color difference meter manufactured by Nippon Denshoku. The b value represents a yellow-blue hue (the positive side being yellowish, and the negative side being bluish), which is best when as small as possible, so long as it does not become too small.

[0020]

#### Working Example 1

An esterification reactor was charged with 30.4 kg of PD and 33.2 kg of PTA, and esterification was carried out for 4 hours under a regulated pressure of 3 kg/cm<sup>2</sup>G and at a temperature of 240°C. The resulting esterification product (40 kg) was transferred to a polycondensation reactor, 2x10<sup>-4</sup> mole of tetrabutyl titanate per mole of the acid component was added, and the polycondensation reaction was carried out for 3 hours at 250°C and under a reduced pressure of 0.4 hPa. The product was rendered into chips by an ordinary method, thereby giving PPT having an intrinsic viscosity of 0.92 and a b value of 4. Using a spinneret having 168 extrusion orifices with diameters of 0.15 mm

each, this PPT was spun at a spinning temperature of 290°C and a spinning rate of 3500 m/min, then taken up, thereby giving an unoriented yarn. This unoriented yarn was oriented and heat-treated under the following conditions, after which it was taken up: drawing ratio, 1.7; drawing speed, 700 m/min; heating roller temperature, 80°C; hot plate temperature, 160°C. The oriented yarn that was obtained had the following yarn properties: 55 d/168; elongation, 23%; boiling water shrinkage factor, 13%. In addition, 300 T/m of twist was applied to this yarn, after which it was sized at 30°C and dried at 85°C, then warped and woven. [The woven fabric] was relaxation-scoured in 97°C water, after which the temperature was raised to 160°C and this was heat-set, thereby producing a twill woven fabric. This twill fabric had a hand distinguished by an exceptionally soft touch.

[0021]

Working Examples 2 to 7

The method of Working Example 1 was carried out, except that the intrinsic viscosity (polycondensation reaction time during PPT production), monofilament size, yarn denier, and number of filaments were changed.

[0022]

Working Examples 8 to 9

The method of Working Example 1 was carried out, except that the temperature of the hot plate at the time of orientation and the boiling water shrinkage factor were changed.

[0023]

Comparative Example 1

The method of Working Example 1 was carried out, except that the temperature of the hot plate used in orientation was set at 110°C, thereby giving a very fine yarn having a boiling water shrinkage factor of 25%. The twill fabric that was obtained with this very fine yarn in the same manner as in Working Example 1 had a hard hand, and was not capable of being furnished for practical use.

[0024]

Comparative Example 2

The method of Working Example 1 was carried out, except that the temperature of the hot plate used in orientation was set at 200°C, thereby giving a very fine yarn having a boiling water shrinkage factor of 2%. However, yarn breakage during orientation was common, and it was impossible to stably obtain the finished product.

[0025]

Comparative Example 3

The method of Working Example 1 was carried out, except that the polycondensation reaction temperature was set at 270°C, thereby giving PPT having an intrinsic viscosity of 0.96 and a b value of 14. Using this PPT, yarnmaking and weaving

were carried out in the same manner as in Working Example 1, but the resulting woven fabric was colored yellow, and was thus impossible to furnish for practical use.

[0026]

Comparative Example 4

The method of Working Example 1 was carried out, except that the polycondensation reaction time was changed, thereby giving a PPT having an intrinsic viscosity of 0.75. Using this PPT, yarnmaking was carried out in the same manner as in Working Example 1. However, yarn breakage was common, and so stable take-up was impossible.

[0027]

Reference Example

The method of Working Example 1 was carried out, except that polyethylene terephthalate (PET) having an intrinsic viscosity of 0.68 was used in place of PPT, thereby giving a twill fabric. This fabric did not have an adequate softness to the touch.

[0028]

The results from Working Examples 1 to 9, Comparative Examples 1 to 4, and the Reference Example are presented in Table 1.

[0029]

**Table 1**

	Intrinsic Viscosity	Mono-filament size (d)	Number of filaments	100W (%)	b value	Hand (score) and acceptability of woven fabrics			
						Softness to touch	Sense of slickness	Drape	Pass/Fail
WE 1	0.92	0.3	168	11	5	8	8	7	Pass
WE 2	"	1.0	"	12	6	7	6	7	"
WE 3	"	0.2	"	10	6	8	6	8	"
WE 4	"	0.3	72	11	5	8	7	7	"
WE 5	"	"	336	13	5	8	8	7	"
WE 6	0.82	"	168	12	5	7	6	6	"
WE 7	1.10	"	"	11	9	8	7	7	"
WE 8	0.92	"	"	4	5	7	6	6	"
WE 9	"	"	"	15	5	5	6	6	"
CE 1	"	"	"	25	6	3	4	5	Fail
CE 2	"	"	"	2	5	Product could not be stably obtained.			
CE 3	0.96	"	"	12	17	7	7	7	Fail
CE 4	0.75	Product could not be stably obtained.							
RE	PET	0.3	168	13	4	4	5	5	Fail

WE = Working Example; CE = Comparative Example; RE = Reference Example

[0030]

(Advantageous Effects of the Invention)

According to the present invention, there are provided very fine yarns composed of PPT, or a polyester consisting primarily thereof, which are able to impart an

outstandingly soft touch to woven and knit goods. Moreover, because the very fine yarns of the present invention are produced by a direct yam-making process, there is no fiber-splitting step as in methods that involve splitting conjugated fibers, thereby enabling inexpensive production.

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F. Metreand  
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